DATEL

# SCM-100, SCM-101
# Four-Channel, Isolated Signal Conditioning Modules

T-71-11-07

## FEATURES

- Wide input span range
- 4-Channel operation
- ±1000 Volts peak isolation voltage
- 156 dB CMR
- ±0.02% Maximum nonlinearity
- ±1 Microvolt/°C input offset drift
- Low cost

## GENERAL DESCRIPTION

The SCM-100 and SCM-101 are low-cost, high performance signal conditioning modules designed to interface with low-level thermocouple and high-level analog input signals respectively. Each module is a functionally complete unit, consisting of four individually isolated input channels multiplexed into a single output amplifier. Common Mode isolation is ±1000 volts peak.

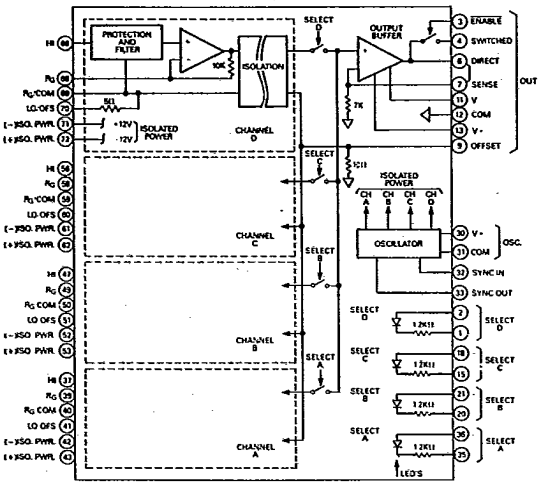
The SCM-100 is optimized for low level signal conditioning. An input span range of ±5 mV to ±100 mV and common mode rejection ratio of 156 dB minimum make this module an ideal choice for interfacing with thermocouples or strain gages, where low level signals require amplification in the presence of high common mode voltages. The SCM-100B features a maximum gain temperature coefficient of ±25 ppm/°C and an input offset temperature drift of only ±1 microvolt/°C maximum.

The SCM-101 is optimized for ±50 mV to ±5V or 4-to-20 mA input signals. Other specifications include a minimum common mode rejection ratio of 145 dB, a maximum gain temperature coefficient of ±25 ppm of FS/°C and a maximum input offset voltage drift of ±5 microvolt/°C.

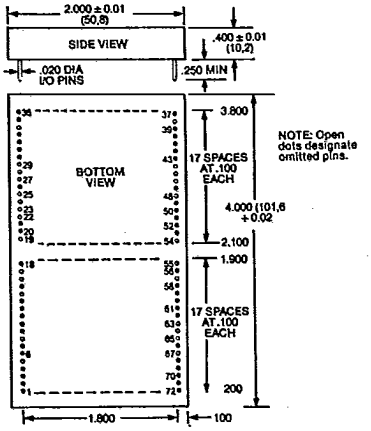
All models feature a minimum channel scanning rate of 400 channels/second. Long term stability is specified at 1.5 microvolts/month and gain nonlinearity as low as ±0.02% maximum. Their combination of functionally complete design, wide input range, high noise rejection, small size, and low cost make these devices an ideal choice for applications involving multi-channel data acquisition systems, computer interface systems, process signal isolators, and temperature measurement and control instrumentation.

Each device is packaged in a compact 2" x 4" x 0.4" encapsulated module.

### SCM-100, SCM-101




### MECHANICAL DIMENSIONS INCHES (MM)




### INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | – CHAN. D. SELECT | 40 | CHAN A RG/COMMON |
| 2 | + CHAN D. SELECT | 41 | CHAN A LO/OFFSET |
| 3 | SWT. OUTPUT ENABLE | 42 | CHAN A (–) ISO. POWER |
| 4 | SWITCHED OUTPUT | 43 | CHAN A (+) ISO. POWER |
| 6 | DIRECT OUTPUT | 47 | CHAN B HI INPUT |
| 7 | OUTPUT SENSE | 48 | CHAN B RG |
| 9 | OUTPUT OFF ADJ | 50 | CHAN B RG/COMMON |
| 11 | OUTPUT POWER, – 15V | 51 | CHAN B LO/OFFSET |
| 12 | OUTPUT POWER, COMMON | 52 | CHAN B (–) ISO. POWER |
| 13 | OUTPUT POWER, + 15V | 53 | CHAN B (+) ISO. POWER |
| 15 | – CHAN C SELECT | 56 | CHAN C HI INPUT |
| 16 | + CHAN C SELECT | 58 | CHAN RG |
| 20 | – CHAN B SELECT | 58 | CHAN C RG/COMMON |
| 21 | + CHAN B SELECT | 60 | CHAN C LO/OFFSET |
| 30 | OSCILLATOR POWER, + Vs | 61 | CHAN C (–) ISO. POWER |
| 31 | OSCILLATOR POWER, COMMON | 62 | CHAN C (+) ISO. POWER |
| 32 | SYNC IN | 66 | CHAN D HI INPUT |
| 33 | SYNC OUT | 68 | CHAN D RG |
| 35 | – CHAN A SELECT | 69 | CHAN D RG/COMMON |
| 36 | + CHAN A SELECT | 70 | CHAN D LO/OFFSET |
| 37 | CHAN A HI INPUT | 71 | CHAN D (–) ISO. POWER |
| 38 | CHAN A RG | 72 | CHAN D (+) ISO. POWER |

T-71-11-07

## FUNCTIONAL SPECIFICATIONS

Typical at +25°C, ±15V dc supplies, unless otherwise noted.

| INPUT CHARACTERISTICS | SCM-100A | SCM-100B | SCM-101 |
|---|---|---|---|
| Number of Channels | 4 | 4 | 4 |
| Input Span Range | ±5 mV to ±100 mV | ±5 mV to ±100 mV | ±50 mV to ±5V |
| Input Offset Voltage, max.[1] | ±20 μV | ±20 μV | ±50 μV |
| Input Noise Voltage[2] | 0.6 μV P-P | 0.6 μV P-P | 0.6 μV P-P |
| Input Bias Current, max. | +8 nA | +8 nA | +8 nA |
| Input Resistance | | | |
| Power On | 100 MΩ | 100 MΩ | 100 MΩ |
| Power Off, min. | 35KΩ | 35KΩ | 74KΩ |
| Common Mode Voltage Range[3], | | | |
| ac, 60 Hz | 750V RMS | 750V RMS | 750V RMS |
| ac or dc, max. | ±1000 V pk | ±1000 V pk | ±1000 V pk |
| Common Mode Rejection Ratio[4], | | | |
| min., G = 1000 | 156 dB | 156 dB | |
| G = 50 | 128 dB | 128 dB | |
| G = 100 | | | 145 dB |
| G = 1 | | | 110 dB |
| Normal Mode Input Without Damage 60 Hz | 130V RMS | 130V RMS | 130V RMS |
| Normal Mode Rejection, | | | |
| min., G = 1000 | 55 dB | 55 dB | |
| G = 100 | | | 55 dB |
| Open Input Detection Time[5] | | | |
| G = 1000 | 6 sec. | 6 sec. | |
| G = 100 | 120 sec. | 120 sec. | |
| **OUTPUT CHARACTERISTICS** | | | |
| Output Voltage Swing[6] | ±5V at ±5 mA | ±5V at ±5 mA | ±5V at ±5 mA |
| Output Offset Voltage, max.[1] | ±12 mV | ±12 mV | ±12 mV |
| Output Noise, dc to 100 kHz | 0.8 mV P-P | 0.8 mV P-P | 0.8 mV P-P |
| Output Resistance | | | |
| Direct Output | 0.1Ω | 0.1Ω | 0.1Ω |
| Switched Output | 35Ω | 35Ω | 35Ω |
| **PERFORMANCE** | | | |
| Gain Equation | G = 1 + 10kΩ/$R_G$ | G = 1 + 10kΩ/$R_G$ | G = 1 + 10KΩ/$R_G$ |
| Gain Nonlinearity[7], max., G = 1 to 100[8] | | | −0.2% min. to −0.55% max. |
| G = 50 to 300 | ±0.03% | 0.02% | |
| Typical, G = 1000 | ±0.03% | ±0.03% | |
| Gain Temp. Coef., max. | ±35 ppm/°C | ±25 ppm/°C | ±25 ppm/°C |
| Input Offset Temp. Drift, max. | ±2.5 μV/°C | ±1 μV/°C | ±5 μV/°C |
| Input Offset Drift vs Time | ±1.5 μV/month | ±1.5 μV/month | ±1.5 μV/month |
| Output Offset Temp. Drift, max. | ±50 μV/°C | ±50 μV/°C | ±50 μV/°C |
| Total Offset Drift, RTI, max. | ±(2.5 +50/G) μV/°C | ±(1 + 50/G) μV/°C | ±(5 +50/G) μV/°C |
| Channel Selection Time[9], max. | 2.5 msec. | 2.5 msec. | 2.5 msec. |
| Channel Scanning Speed, min. | 400 channels/sec. | 400 channels/sec. | 400 channels/sec. |
| Channel Select Input Reverse Voltage Rating, max. | 3V | 3V | 3V |
| **POWER REQUIREMENTS** | | | |
| Analog Supply, rated value | ±15V dc ±10% | | |
| Analog Supply Range, max. | ±12V dc to ±18V dc | | |
| Analog Supply Current, max. $\pm V_s$ = 15V dc | ±4 mA | | |
| Oscillator Supply, rated value | +13.5V dc to +24V dc | | |
| Oscillator Supply, absolute value max. | +26V dc | | |
| Oscillator Supply Current, max. $+V_{OS}$ = +15V | 40 mA | | |
| Power Supply Sensitivity, RTI | | | |
| Analog Supply | 1 μV/V | | |
| Oscillator Supply | 1 μV/V | | |

| PHYSICAL/ENVIRONMENTAL | |
|---|---|
| Operating Temp. Range | 0°C to +70°C |
| Storage Temp. Range | −55°C to +85°C |
| Relative Humidity[9] | 0 to 85% |
| Case Size | 2" x 4" x 0.4" (50,8 x 101,6 x 10,2 mm) |

**FOOTNOTES:**

1. Adjustable to zero.
2. $R_S$ = 1KΩ, 0.01 Hz to 100 Hz.
3. Channel to channel or channel to ground.
4. $R_S \leq 100\Omega$, f ≥ 50 Hz.
5. Response time can be reduced by addition of external resistors.
6. Short circuit protected.
7. Gain nonlinearity is specified as a percentage of output signal span representing peak deviation from the best straight line.
8. A negative gain error is purposely introduced to allow all channels to be matched at G = >1 by trimming the input gain. The gain is then set by the output gain adjustment.
9. To +0.01% full scale.

## TECHNICAL NOTES

1. To minimize coupling between input and output, keep all leads associated with signals on the input as far as possible from leads associated with output signals. The use of a guard track on both sides of the board (see typical connection) may be helpful. The power supplies should be decoupled with tantalum capacitors mounted as close to the device as possible.
2. For lowest noise, the grounding scheme shown in the typical connection diagram should be used. To prevent power supply currents from flowing in the low lead of the signal output, the output signal common should be tied directly to the output power common pin (pin 12), with the power supply returns brought separately to pin 12.
3. When using an unregulated power source for the oscillator, a 0.1 μf capacitor should be connected directly from the output power common (pin 12) to the oscillator power common (pin 31). Since the output and oscillator circuits are not fully isolated, a dc path must exist between the two power supply commons. A one or two volt potential difference between the two power supply commons will not affect operation.
4. Channel selection is determined by the select inputs. Each select input consists of an LED in series with a resistor. Turning the LED on (± ≥2.5 mA) turns the channel on, and turning the LED off (± ≤50 μA) turns the channel off. The easiest way to use the select inputs is to

tie all the Select (+) inputs (pins 2, 18, 21 and 36) to +5V and drive the Select (–) inputs (pins 1, 15, 20 and 35) from TTL logic. Open-collector or totempole outputs can be used.

With a +15V logic supply, a standard CMOS decoder or gate can supply enough current to drive the select inputs. At higher CMOS supply voltages, more current than the required 2.5 mA will flow into the select inputs. While this will not affect operation, it can be brought back to the minimum value if desired by putting a resistor in series with the decoder or gate output and the select (–) input. For 10V dc operation, a 2KΩ resistor should be used and at 15V dc, a 2.9KΩ.

5. The maximum reverse voltage applied to any select input must be limited to 3V to avoid damage to the LED. Maximum forward current should be kept below 25 mA. Select inputs are isolated from all other circuits in the module and may be operated at up to ±50V with respect to output and power ground. Channels may be selected in any order with no restrictions on rate or duty cycle — except the 2.5 nanoseconds settling time for channel access. However, selecting two or more channels simultaneously for more than a few microseconds will result in very long settling times.
6. Output filtering is not required in most applications, since the affect of the small carrier-related noise spikes on the output (<1 =mV peak-to-peak, 100 kHz B.W.) drops off rapidly as bandwidth decreases. To eliminate the carrier noise, a simple R-C filter (for example — 1KΩ, 0.0047 μf) may be used at the output. Only one filter is required, even when using multiple modules. However, if the load to be driven has an input resistance of less than 10 MΩ, a buffer will be needed.
7. Output errors caused by differences in individual oscillator frequencies may occur in applications where multiple SCM-100/101's are used in close proximity or when system clock signals are present near the isolator. To eliminate these errors, multiple units may be synchronized by connecting the Sync Output (pin 33) of one module to the Sync Input (pin 32) of the adjacent module. The first module of a group may be synchronized to an external source via the SYNC IN (Pin 32). Sync wiring should be separated from analog signal runs to keep noise pickup at a minimum. (See External Synchronization.) The frequency of the external Sync Source (if used) will have a slight effect on the gain and output offset of the device. Thus, any adjustments should be made with the modules synchronized.

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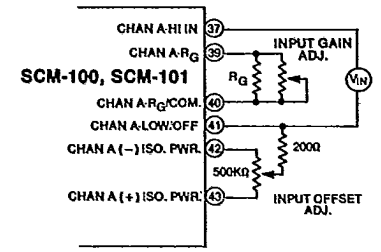
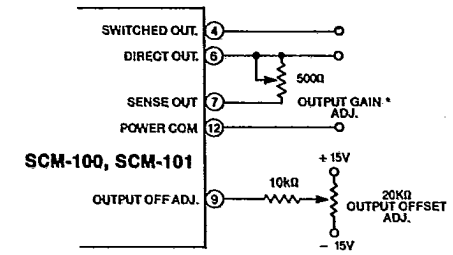
## TYPICAL CONNECTION AND CALIBRATION

### INPUT OFFSET AND GAIN ADJUST



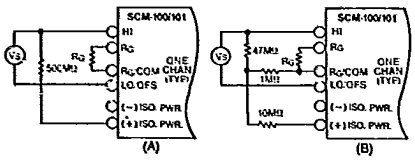

### OUTPUT OFFSET AND GAIN ADJUST




TRIM POTS ARE 10 TURN.

GAIN ADJUST RANGE SHOULD NOT EXCEED 10% TO MAINTAIN GAIN STABILITY

### OPEN INPUT DETECTION



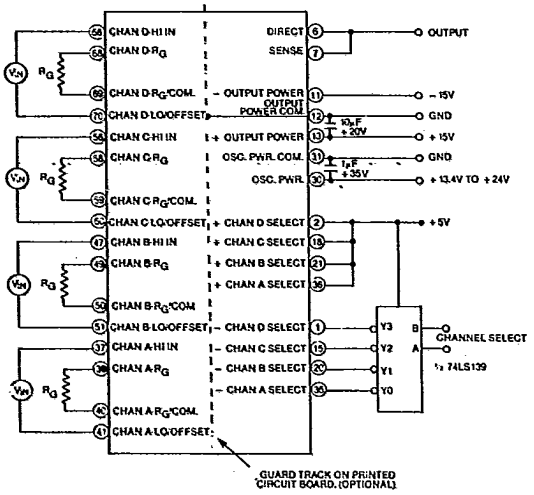

**GAIN ADJUST** — The gain of each channel is independently adjusted by an external gain resistor ($R_G$). A trimpot may be connected in parallel with $R_G$ to trim out $R_G$'s tolerance and the modules gain error. $R_G$ should be chosen to give an untrimmed gain slightly less than the desired trimmed gain.

**OFFSET ADJUST** (optional) — The input offset of each channel may be fine adjusted with an external trimpot if required. This fine adjust has a limited range of ±250 μV and can be used to adjust each channel for zero offset while operating at the desired gain. Since the range of this adjustment is so limited, it is recommended that the output offset be adjusted first. Output Offset Adjustment should be made as follows:

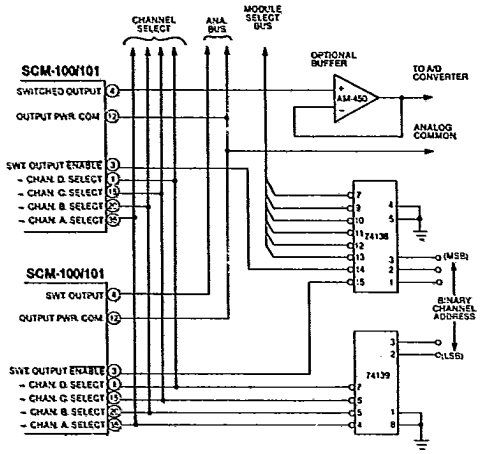
1. Select the desired channel.
2. Apply zero volts in and set for unity gain. (This can be done by disconnecting $R_G$.)
3. Set the OUTPUT OFFSET ADJUST for an output of 0V.

Since only a few nA of input bias current is available to charge the input filter, the response time for open input detection can be in the tens of seconds. Shorter response times and a positive overscale if required may be achieved with one of the above circuits which will augment or reverse the input bias current. Either circuit will supply a bias current of approximately 20 nA which may be used to aid or oppose the 3 nA supplied from the module. Circuit A has the advantage of simplicity, however, the high value resistor may not be readily available. Circuit B solves the problem at the expense of complexity. The component values may be varied to give an optimum trade of bias current for response time as required. The values shown will give a typical response time of 2 to 5 seconds.

## TYPICAL CONNECTION
SCM-100, SCM-101




## EXPANSION TO 32 CHANNELS

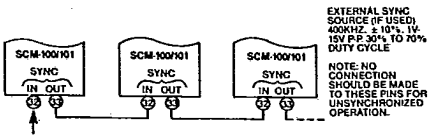



The SCM-100/101 are mainly used in Data Acquisition systems to maintain high system accuracy in electrically noisy industrial environments.

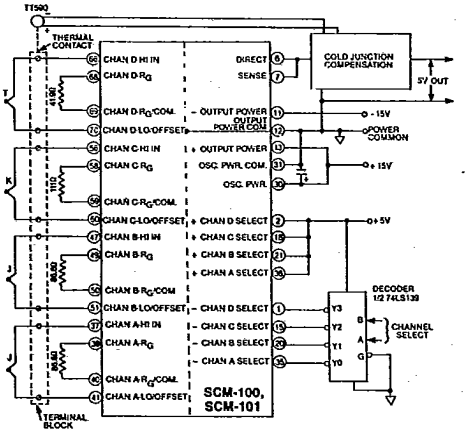
It is possible to operate up to sixteen modules in parallel giving 64 input channels. However, it will be necessary to divide the select inputs into several groups to avoid overloading the decoder.

The above diagram shows the SCM-100/101 expanded to 32 channels. The CHANNEL SELECT inputs are driven in parallel from a single 74139 decoder. Module selection is achieved by driving the enable inputs with a 74138 decoder. All + channel select pins are tied to +5V.

## EXTERNAL SYNCHRONIZATION
(see Tech Note 7)




## THERMOCOUPLE TEMPERATURE MEASUREMENT




In this application, the SCM-100 is set up as a four-channel thermocouple input system with isolation, amplification, and multiplexing provided by the module. Various thermocouple types are used, and the gain adjust pots on each channel have been selected to take the standard ANSI range for each thermocouple to a 5V output span. A universal cold junction compensator is used to compensate for the temperature of the reference junction which is formed where the thermocouple leads are terminated.

**ORDERING INFORMATION**

| MODEL |
|---|
| SCM-100A |
| SCM-100B |
| SCM-101 |